

Section of Epidemiology and State Medicine

President—E. H. R. HARRIES, M.D.

[November 28, 1941]

Some Practical Considerations in the Control of Louse-borne Typhus Fever in Great Britain in the Light of Experience in Russia, Poland, Rumania and China

By MELVILLE D. MACKENZIE, M.D.

ABSTRACT.—This paper deals with some aspects of the control of louse-borne typhus fever. The epidemic form is associated with famine and overcrowding. In producing an epidemic in a hitherto endemic area malnutrition is of greater importance than overcrowding; another factor which brings this about is widespread movement of civil or military population thus bringing non-immunes into a district where typhus is endemic.

Endemic typhus usually occurs in the early months of the year, whilst the epidemic form may appear at any time. Conditions under which epidemic typhus occurs favour the outbreak of other diseases so that an uncomplicated case is rarely seen.

Louse-borne typhus fever lasts from twelve to sixteen days. The incubation period is usually twelve to fourteen days, though it may be from five to twenty-one days. The onset is sudden, but is often preceded by malaise and a rise of temperature. Two common initial symptoms are acute frontal or occipital headache and bronchitis. The first sign may be mental confusion or delirium. Acute delirium is usually present after the first week.

The diagnosis at the end of the first week may be determined by the Weil-Felix reaction. The author discusses the practical value of this and the question of immunity to second attacks of the disease. The most important diagnostic signs are the absence of the rash from the face and the fact that "cropping" does not occur in the appearance of the exanthem. A description follows of the details of the administrative control of typhus with which the writer was associated in Mesopotamia, Poland, Russia, Rumania and China and the methods of disinfection employed in these countries.

Attention is drawn to the great danger to which personnel are exposed; the special clothing that must be worn and other methods of protection are described in detail. Vaccines should not be relied upon in the present state of our knowledge. In the control of the disease even greater importance is laid on reducing lice in the population generally than in attempting to trace the remoter contacts of cases. The methods by which lice are transferred are then discussed and the predominant importance of mechanical transference is stressed. The importance of dealing with malnutrition in typhus outbreaks is referred to and the administrative and practical details for dealing with a case of typhus are given. In his conclusions, the writer emphasizes the following points: The rapidity of the spread of the disease; the difficulty of the diagnosis; the necessity for complete thoroughness in disinfection and for detailed supervision of the protection of personnel, who should be under 30 years of age, as the mortality rate increases greatly after this age.

RÉSUMÉ.—Cet article concerne certains aspects du contrôle du typhus transmis par les poux. La forme épidémique est associée à la famine et au surpeuplement. La famine est plus importante que le surpeuplement dans la production d'une épidémie dans une région de typhus endémique. Les grands mouvements de la population civile ou militaire peuvent produire le même effet, en amenant des individus non immuns dans une région de typhus endémique.

Le typhus endémique apparaît le plus souvent vers le commencement de l'année, tandis qu'une épidémie peut se déclarer à n'importe quel moment. Les conditions qui amènent le typhus épidémique favorisent aussi d'autres maladies, de sorte qu'on voit rarement un cas de typhus sans complications.

Le typhus transmis par les poux dure de 12 à 16 jours. La période d'incubation dure le plus souvent de 12 à 14 jours, mais peut durer de 5 à 21 jours. Le début est brusque, mais souvent précédé de malaise et d'une élévation de la température. Deux symptômes initiaux fréquents sont une céphalée frontale ou occipitale et une bronchite. Le premier signe peut être une confusion mentale ou un délire. Le délire aigu est généralement présent après la première semaine.

La réaction de Weil-Felix permet de poser le diagnostic à la fin de la première semaine. L'auteur discute sa valeur pratique, ainsi que la question de l'immunité contre une seconde attaque de la maladie. Les signes diagnostiques les plus importants sont l'absence de l'éruption sur la figure et l'absence de poussées successives de l'exanthème.

Il suit une description des mesures administratives contre le typhus dans lesquelles l'auteur a pris part en Mésopotamie, en Pologne, en Russie, en Roumanie et en Chine, et des méthodes de désinfection adoptées dans ces pays. Il attire l'attention sur le grand danger couru par le personnel, et décrit le costume spécial nécessaire et d'autres mesures protectrices. Dans l'état actuel de nos connaissances il ne faut pas se fier aux vaccins. Pour le contrôle de la maladie l'auteur attache encore plus d'importance à la réduction des poux qu'à la découverte des contacts éloignés du malade. Ensuite l'auteur discute les modes de transmission des poux, et insiste sur la prédominance du transport mécanique, puis il parle de l'importance de la lutte contre la malnutrition pendant une épidémie de typhus, et décrit les détails pratiques et administratifs du traitement des cas individuels.

En conclusion, l'auteur appuie sur les faits suivants: 1° la rapidité de la propagation de la maladie, 2° la difficulté du diagnostic; 3° la nécessité de la désinfection absolument complète et de la surveillance soigneuse de la protection du personnel, qui doit être âgé de moins de 30 ans, car la mortalité est beaucoup plus élevée au-dessus de cet âge.

RESUMEN.—Este artículo considera unos aspectos del control del tifo transmitido por piojos. La forma epidémica se asocia con hambre y apiñadura. Para la producción de una epidemia en una región hasta aquí endémica, tiene más importancia la malnutrición que la apiñadura; otro factor que efectúa ésta es el movimiento extensivo de la población civil o militar, llevando personas no inmunes a una región donde el tifo está endémica.

El tifo endémico ocurre generalmente temprano en el año, mientras que la forma epidémica puede encontrarse a cualquier hora. Las condiciones en que ocurre el tifo epidémico favorecen el brote de otras enfermedades, de suerte que rara vez se ve un caso complicado.

El tifo transmitido por piojos dura de 12 a 16 días. El período de incubación es generalmente de 12 a 14 días, aunque puede ser de 5 a 21 días. El ataque es súbito, pero se precede muchas veces de malestar y alza de temperatura. Dos comunes síntomas iniciales son cefalalgia aguda frontal u occipital, y bronquitis. Puede ser la perturbación mental o el delirio el primer señal. El delirio agudo se encuentra por lo general tras la primera semana.

Acabada la primera semana, el diagnóstico puede hacerse por medio de la reacción de Weil-Felix. Háblase del valor práctico de ésta y del problema de inmunidad a ataques subsecuentes del mal. Las señas diagnósticas más importantes son la ausencia de erupción en la cara y lo de que no ocurren retoños sucesivos en el aspecto de la exantema. Sigue una descripción de los detalles de control administrativo del tifo a los que estaba asociado el autor en Mesopotamia, Polonia, Rusia, Rumania y China, y de los métodos de desinfección empleados en estos países.

Llámase la atención al gran peligro que incurre el personal; descríbese detalladamente la ropa especial que hay que llevar, y otros métodos de protección. No se debiera confiar

en vacunas en el estado actual de nos conocimientos. En el control del mal aun más importa el reducir piojos en la población general que los esfuerzos para trazar los contactos algo apartados de casos. Luego se pasa en revista los métodos por que transmitense los piojos, y se hace notar la importancia suma de transferencias mecánicas. Se menciona la importancia de entenderse con la malnutrición en los brotes del tifo, y se expone los pormenores administrativos y prácticos del tratamiento de un caso de tifo. Concluyendo, el autor insiste sobre los puntos siguientes: diseminación rápida de la enfermedad; dificultad del diagnóstico; necesidad de una desinfección acabadísima y de una supervisión circunstancial de la protección del personal, quien debiera tener menos de treinta años, edad por encima de la que aumenta mucho la mortalidad.

RESUMO.—Esta dissertação trata de alguns aspectos do control da febre tífica transmitida por piolhos. A forma epidêmica aparece quando ha fome e grandes aglomerações de gente. A alimentação deficiente é de maior importancia no aparecimento da epidemia num meio endêmico do que as grandes aglomerações de gente; um outro factor que a favorece é o movimento em grande escala da população civil ou de grandes contingentes de tropas, trazendo assim individuos não imunes para localidades onde o tifo é endêmico.

O tifo endêmico aparece geralmente nos primeiros meses do ano, ao passo que a forma epidêmica pode aparecer em qualquer época. As condições em que aparece o tifo endêmico favorecem o aparecimento de outras doenças, dando isto o resultado de raramente se encontrar um caso sem complicações.

O tifo transmitido por piolhos dura de 12 a 16 dias. O periodo de incubação é geralmente de 12 a 14 dias, e nalguns casos de 5 a 21 dias. O ataque é subitico, mas é precedido muitas vezes de mal estar e de aumento de temperatura. Dois sintomas iniciaes muito vulgares são fortes dôres de cabeça, na região frontal e bronquite.

O primeiro sinal pode ser perturbação mental ou delirio. O delirio agudo manifesta-se geralmente depois da primeira semana.

O diagnostico no fim da primeira semana pode ser decidido pela reação Weil-Felix. O autor discute o seu valor pratico e a questão de imunidade de ataques consecutivos da doença. Os sinais mais importantes para o diagnostico são a ausencia de erupção na face e o facto da mesma não se manifestar em dias sucessivos, quando aparece o exantema. Segue a descrição dos pormenores do control administrativo do tifo com que o autor esteve associado na Mesopotamia, Polonia, Russia, Roménia e China, e os meios de desinfeção adotados nestes paizes.

Chama-se a atenção para o grande perigo a que está exposto o pessoal hospitalario; o vestuario especial que deve usar e os outros meios de proteção são descritos minuciosamente. Não se deve ter muita confiança nas vacinas, no estado presente dos nossos conhecimentos. No control da doença muito maior importancia tem a despiolhação da população em geral, do que tentar descobrir os contactos mais remotos dos casos existentes. Os meios pelos quaes se faz a transferencia dos piolhos são enumerados em seguida e a importancia predominante da transferencia mecanica deve ser bem marcada. A importancia da má alimentação nas epidemias de tifo e os pormenores das medidas administrativas e praticas a tomar em casos de tifo tambem foram mencionados. O autor nas suas conclusões acentuou os pontos seguintes: A rapidez do alastramento da doença; a dificuldade do diagnostico; a necessidade da completa desinfeção e de minuciosa fiscalisação de proteção do pessoal, que deve ser de menos de 30 anos de idade, por ser notorio que o coeficiente da mortalidade aumenta muito em individuos de mais idade.

INTRODUCTION

EVERY year brings more evidence of how widespread rickettsial diseases are, particularly amongst animals, and there are now few areas of the world where rickettsial conditions have not been found. In addition to the new knowledge of the widespread distribution of the Rickettsia themselves, a steadily increasing number of species of arthropods (ticks, fleas, mites) is being incriminated. Louse-borne rickettsial infection is, however, unique, in the fact that, as far as is known, it is the only type that is primarily a disease of man and consequently the only one which occurs in epidemic form. All other rickettsial conditions are, as far as man is concerned, endemic and localized, being really accidental infections. At first sight it may perhaps seem strange that flea-borne typhus does not spread in epidemic form like plague. This is probably due to two factors. In the first place the rat only carries the virus of the disease for a very short

time and therefore relatively few fleas are infected; secondly the disease is not fatal to the rat so that the fleas have no reason to drop off and seek other hosts.

The present paper deals only with louse-borne typhus fever, but before leaving the other forms of *Rickettsia* I should like to mention the transmutation of the mild flea-borne murine strain to the deadly louse-borne strain. In some parts of the world, particularly Mexico and Manchuria, both the flea-borne murine type and the louse-borne types exist side by side and appear largely to remain separate pathological entities. A comparable occurrence of tick-borne and louse-borne typhus is found in Rumania. On the other hand there is evidence that the ordinary flea-borne murine typhus, if transmitted through lice, will produce a disease both clinically and with immunological reactions indistinguishable from classical louse-borne typhus. From an epidemiological point of view this fact may be of very great importance and particularly so in Great Britain where both the flea-borne and tick-borne forms of the disease have occurred within recent years. Such an introduction amongst a louse-infested section of the population might cause, according to our latest evidence, an outbreak of classical typhus in this country. Moreover at present we know very little about the amount of endemic murine typhus amongst rats and other mammals in this country, though it is known that the rats of Paris, for example, are infested with murine typhus. As the object of this paper is essentially practical, it is unfortunately not possible to enter further into the extremely interesting facts now known regarding the transmutation of the *Rickettsia* viruses, their varying virulence according to the insect vector, and their relation to one another as shown by cross-immunization and agglutination.

PREDISPOSING CONDITIONS

Louse-borne typhus fever is an acute infectious disease lasting from twelve to sixteen days and characterized by a continued temperature, a generalized maculopapular rash which may become hæmorrhagic, severe toxæmia, and marked nervous manifestations. The disease is carried by lice and spreads with extreme rapidity especially through a badly nourished population. Thus in Russia during the period 1919 to 1922 the estimated number of cases was 10,000,000, with 3,000,000 deaths, in a population of 120,000,000. These are stupendous figures. Their scale can be realized to some extent by recalling that in the much-described typhus epidemic in London in 1856 only 1,062 cases were recorded as treated in the London Fever Hospital out of a population of 3,000,000 whereas in Russia in the year 1921 alone there were 4,000,000 cases in a population of 120,000,000. These figures can, of course, only be approximate, as many cases diagnosed as typhus were in reality instances of relapsing fever; on the other hand a vast number of cases of typhus were never admitted to hospital and so remained unrecorded. Of the cases admitted to hospital very many were never notified by the Russian medical officers owing to pressure of work. So uncertain were the statements that when we went into a new district to survey the amount of typhus present we found it more useful to base our estimate on the number of women with recently shaved heads seen in the streets, than to rely upon notification figures. All cases on admission to hospital for typhus were closely shaved and consequently it was possible to sit in a café and determine the proportion of women with closely cropped heads to the general population and so to estimate roughly the amount of typhus in the region.

Epidemic typhus fever, is, classically, associated with famine and overcrowding, but there is a third factor which, to my mind, is perhaps of even greater importance, namely, widespread movements of military or civilian populations bringing non-immunes into a district where the disease is endemic or carrying the disease into a typhus-free region. A third possibility is that such movements may introduce into an endemic region either a new strain of the disease or one of enhanced virulence. The first mode of infection I saw well demonstrated in the epidemic in North China two years ago which was due to the introduction of masses of non-immunes with the Army into areas in North China where the disease was endemic. The second method occurred on the return of Polish prisoners of war to Poland from Siberia in 1919-1922. These men, women and children had been heavily infected with typhus in Russia, and passed into Poland at the rate of tens of thousands a day, going to regions in which the disease either was already endemic or did not exist previously; in both cases widespread epidemics resulted.

Apart from mass movements of the kinds instanced above, a striking feature of epidemics is the amount of local movements of the population that they initiate. Once

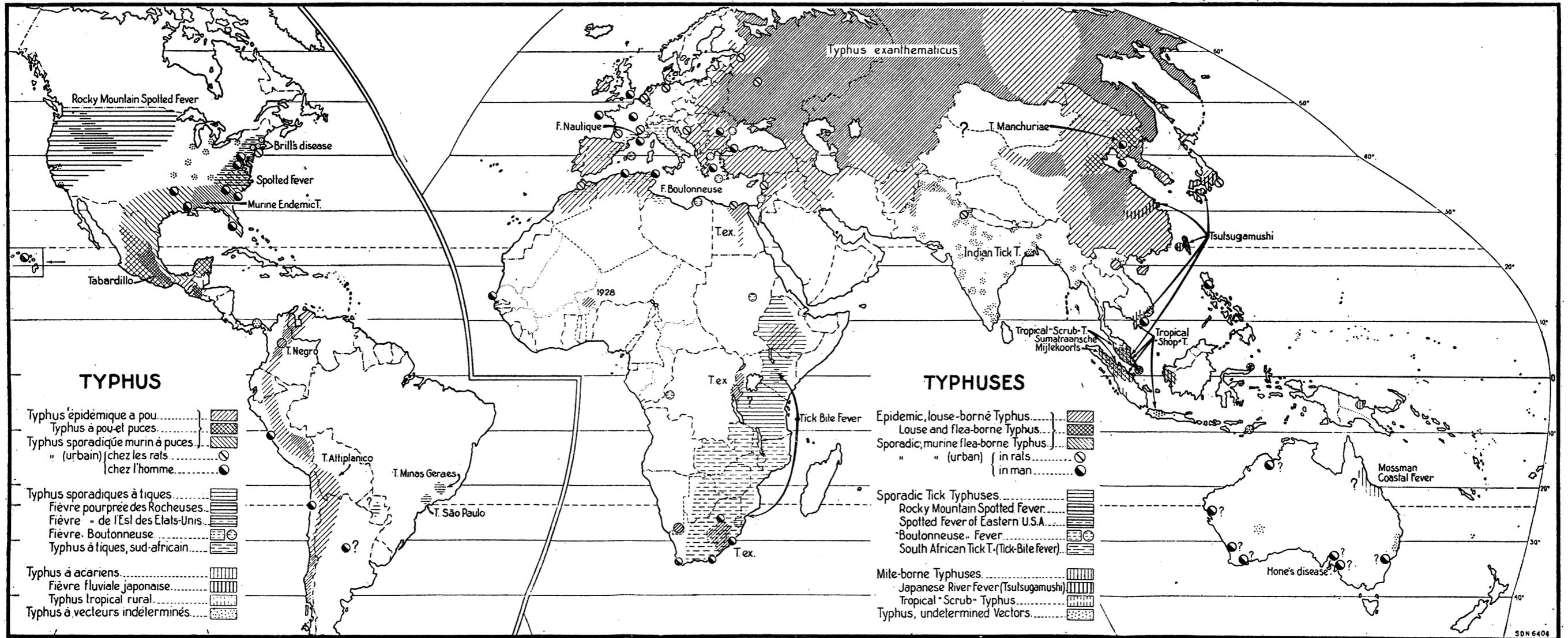


CHART 5.—Recent distribution of typhus. (From *League of Nations Epidemiological Report*, 1936.)

typhus is really established in a district, fear of contracting the disease, combined with terror of the appearance and acts of delirious patients, is soon widespread. Transport of food and fuel quickly breaks down, starvation threatens, the sick are abandoned, often in the roads, the houses are deserted and the terrified population flees from the infected area into a neighbouring village or another part of the town as the case may be, carrying the disease with them. Too often the hospital staffs may flee with the others.

Passing to other predisposing causes, of Murchison's two classical factors—famine and overcrowding—I should certainly lay the greater stress on the former. Typhus will spread rapidly through a population where there is no overcrowding. On the other hand as far as my experience goes, overcrowding alone is not sufficient to cause an epidemic in an endemic area, whereas famine certainly is. In many of the most heavily infected areas of Poland and Russia there was no overcrowding—in fact the reverse—as thousands of famine-stricken persons had left the villages to seek food in the town. I saw a striking example of the relatively greater importance of semi-starvation as compared with overcrowding in the Kirghiz villages north of the Caspian Sea. These villages, very remote in summer, are in winter completely cut off by 50 miles of snow from the nearest neighbour, and communications with the outside cease after the snow falls in late October. Typhus is ordinarily mildly endemic in this region, but during years of famine—the only new factor—the disease becomes widely epidemic. I had occasion to visit a number of these villages in the middle of winter, and I then realized how important a single factor, under-nourishment, may be in producing an outbreak of the disease in an isolated endemic area. The importance of semi-starvation in spreading the disease is convincingly shown by the rapidity with which epidemic typhus disappears in a district once a supply of food becomes available, and agricultural and economic reconstruction are effected. Overcrowding, inasmuch as it increases the number of lice and the facilities for the transfer of the insects, obviously must play an important part, but for the enhanced virulence required to maintain an epidemic in an endemic area, I believe that a severe degree of under-nourishment is necessary. Despite the fact that typhus is so closely related to malnutrition, it must not be forgotten that individuals who are strong and well nourished readily become infected, and very frequently die.

INFLUENCE OF CLIMATIC CONDITIONS

So far as climatic conditions are concerned, louse-borne typhus fever is a disease of cold countries and is unknown in tropical regions, though it may occur in the mountainous sectors. I have for example seen it practically on the Equator in Bolivia at a height of 15,000 feet in winter, and in Uganda the disease has occurred at an elevation of 5,400 feet. The distribution of louse-borne typhus broadly speaking may be said to cover all parts of Europe, North and Central Asia, the line of the Andes in South America and localized sections of Africa, particularly in the North. In considering the relations of louse-borne typhus to climatic conditions it must be remembered that the behaviour of endemic typhus is different from that of the disease in epidemic form. In countries where the disease is endemic it shows a constant rhythm in its visitations. Year after year the curve starts in late November or December, reaching an annual maximum in March or April, and continues until the end of June or July (Chart 1). It does not,

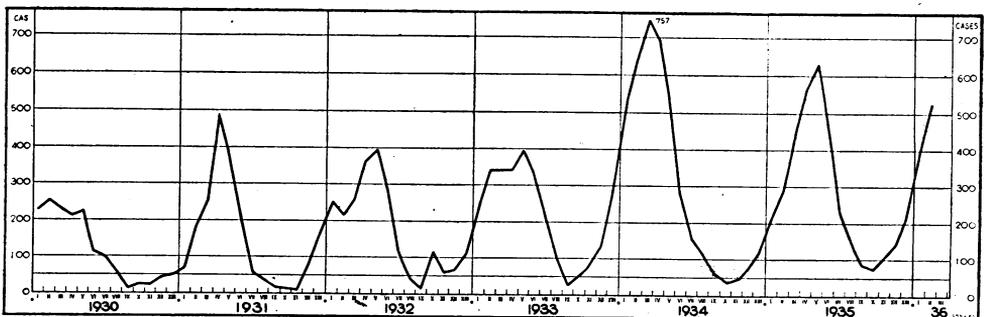


CHART 1.—Typhus cases reported in Poland by four-week periods from 1930-1936. (From *League of Nations Epidemiological Report*, 1936.)

therefore, as is often thought, actually coincide with the cold period of the year but is still widespread in the heat of May and June. Epidemics of typhus on the other hand, whether in an endemic area or amongst non-immunes, can occur at any time of the year. We have had an illustration of this fact in the present epidemic in Spain, which started in April and reached its maximum during some of the hottest months of the year (Chart 2). A further example was the occurrence of typhus in Poland in 1919-1920 (Chart 3). This was superimposed on an endemic focus, but continued in epidemic

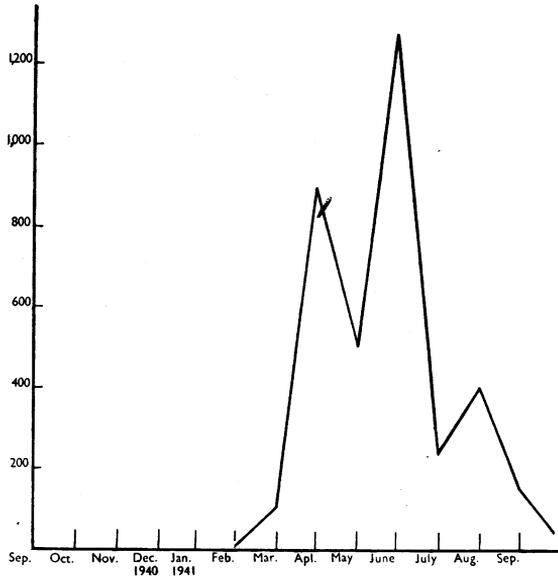


CHART 2.—Typhus in Spain, September 1940-41.

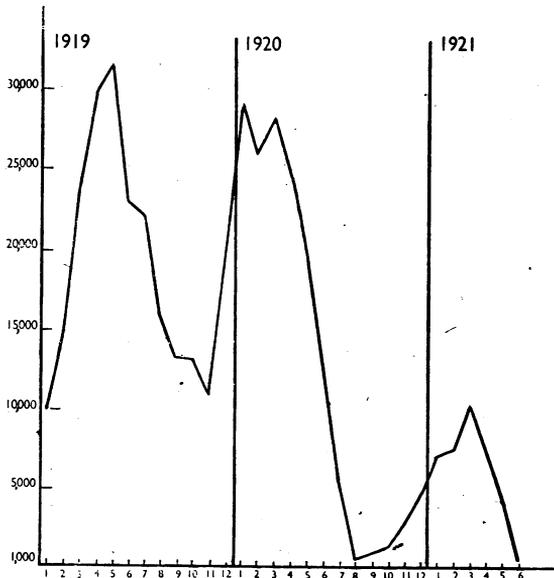


CHART 3.—Poland: Typhus cases in 1919, 1920 and to July 1, 1921.

form throughout the summer, autumn, and winter of 1919, returning to the normal endemic curve in 1920, viz. a maximum in the first six months of the year and an almost complete absence in the summer from the beginning of August onwards.

The question of the method by which the disease in endemic areas is continued between outbreaks has not been definitely answered. In an endemic typhus area one of the most striking features is the complete cessation of all cases after June or July. Repeated and careful searching during the following few months fails to reveal any cases of the disease. Though undoubtedly "missed" cases may occur during the period between gross manifestations of the disease, I believe from such investigations as I have been able to make that it is very doubtful whether these are sufficiently constant to maintain the virus from July to November or December each year. There is, of course, the possibility that a proportion of the patients may remain as Rickettsia "carriers". A further suggestion has been made by Cuica, Balteanu and Constantinesco (1935), who have pointed out, in the light of recent work on murine typhus: (1) the difficulty of tracing infection in non-epidemic periods from one case to another; (2) the failure to eradicate the disease from endemic areas by the isolation and delousing of definite cases; (3) the peculiar distribution of the disease and its comparative benignity in individuals born in endemic regions as compared with others. All these suggest the existence of mild, if not wholly inapparent, infections, yet ones capable of inducing immunity. An interesting point of difference between endemic and epidemic typhus relates to the virulence of the disease. In the endemic form the death-rate is generally low and fairly constant. In epidemics, although it is generally impossible to obtain accurate figures the death-rate is very variable, probably between 20% and 72%. In stating any figures, however, it must be remembered that much depends on such factors as the age of the population at risk, the hospital and treatment facilities, &c., existing, as well as the fact that figures are almost always based on hospital admissions, which do not include the mild cases amongst the children and younger members of the community. A further indeterminate factor affecting the death-rate figure is the number of non-immunes who have entered the endemic area in cases in which there has been movement of population.

The question of immunity in populations in endemic areas is of great interest. It is probably very rare for an individual to have a second attack of typhus. On the other hand individuals coming into an endemic area as adults invariably appear to get the disease more severely than adults of similar age in the endemic region. For instance in one of the endemic areas of China the death-rate amongst all Chinese adults admitted to a hospital under our supervision was 7.6% whereas that for Japanese who were newcomers to the region was 20.6%. There were probably factors which rendered these figures not directly comparable, but they bear out one's constant experience with the personnel of foreign relief units who develop the disease in endemic areas. One explanation referred to above is that population in an endemic area may be partially immunized by a milder form of typhus, possibly murine, which may even pass unnoticed by the individual.

The severity of the disease varies greatly with the age of the patient. From extreme childhood the death-rate progressively rises, until after the age of 50 the disease is practically always fatal. I cannot recollect seeing anyone over 55 who recovered, whether a native or foreigner, in an epidemic area (Chart 4, p. 8).

There is one other point in connexion with the striking variations in the virulence of the disease. It is probable that the virulence of epidemic typhus may be increased by passage through human beings, as, I think, there is no doubt the highest death-rates appear in the last stages of an epidemic. In this connexion it is of interest to note that the virus of murine typhus appears to gain in virulence in white mice on passage through animals (Giroud and Panthier, 1939, *Trop. Dis. Bull.*, 36, 984, abstracted from *Bull. Soc. path. exot.*, 32, 14).

The commonest length for the incubation period is twelve to fourteen days, though periods of five to twenty days have been recorded. In practice, it is difficult in epidemics to determine the time of the incubation as the patient has often been exposed daily to the possibility of infection. The estimation is further complicated by the fact that the patient often feels out of sorts for some days prior to the rise of temperature. Space does not permit me here to enter into the bionomics of lice, and I would only point out in this connexion that infectivity is not established in the louse until the sixth or seventh day after it has fed on a case of typhus.

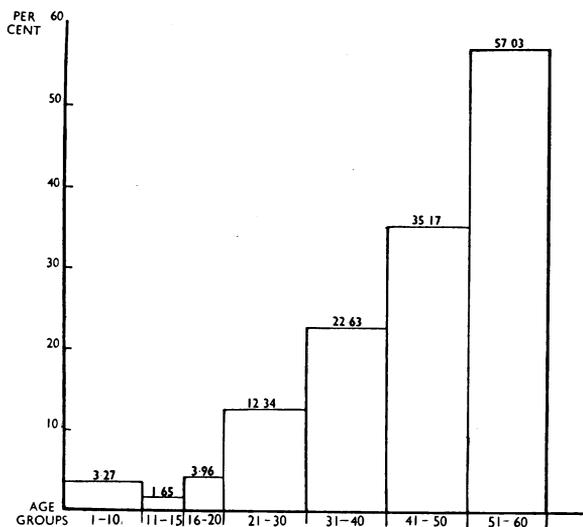


CHART 4.—Typhus mortality rate at different age-groups amongst cases admitted to the London Fever Hospital between 1862-1870. (Murchison, "Continued Fevers", page 238.)

CLINICAL ASPECTS

Turning now to the clinical aspects of typhus, the disease has been incomparably described by Murchison in his "Continued Fevers" (1873), and one has only to work amongst typhus to realize the greatness of the writing of this physician. In the very great number of cases I have seen, the symptoms manifested by the patients only serve to emphasize in my mind the accuracy of Murchison's observations. Here is his summary of the clinical characters of the disease to give a general idea of a typical case.

"Occasionally it is preceded by one or more days of slight indisposition, characterized by lassitude, vertigo, slight headache and loss of appetite, but not such as to incapacitate the patient from following his ordinary employment. With, or oftener without, these premonitory symptoms the patient is seized with slight rigors or chilliness, followed by lassitude and disinclination for exertion, frontal headache, pain in the back, pains like those from bruises in the limbs, especially in the thighs, loss of appetite and often, for a day or two, irregular chills and slight perspirations. For two or three days although the temperature may be 5° or more above the normal standard, the patient complains of chilliness, and sits close to the fire. . . . Occasionally there is nausea but rarely vomiting; the abdomen is free from pain, but there may be tenderness in the hepatic region; the bowels are constipated. . . . The respirations are somewhat accelerated and sometimes there is a slight cough. The face is flushed and dusky; the edges of the eyelids are tumefied, the conjunctivæ are injected; and the eyes water. The expression at first betokens languor and weariness but soon becomes dull, heavy, and stupid. . . . The sleep is disturbed by painful dreams and sudden starts, and after three or four nights there is talking in the sleep with slight delirium between sleeping and waking. When awake the patient is still conscious though perhaps somewhat confused in memory and intellect. With all this there is early and rapidly increasing muscular prostration; the gait is tottering, the hand shakes, and there may be tremors of the tongue; soon there is an intolerable sensation of complete exhaustion so that about the third day the patient is compelled to keep his bed. Between the fourth and seventh days, usually on the fourth or fifth, an eruption appears on the skin. It is composed of numerous spots of irregular form, varying in diameter from three or four lines to a mere speck, which are either isolated, or grouped together in patches presenting a very irregular outline, and often closely resembling the eruption of measles. At first, these spots are of a dirty pink or florid colour, and very slightly elevated above the skin and they disappear upon pressure; but after the first or second day they usually become darker and more dingy, they resemble reddish-brown stains, are no longer elevated above the skin, and do not disappear on pressure. They have

no defined margin, but merge insensibly into the colour of the surrounding skin. These spots usually come out first on the anterior fold of the axillæ and on the sides of the abdomen, and thence they spread to the chest, back, shoulders, thighs, and arms; in some cases they are first seen on the backs of the hands, they are most common on the trunk and arms and are very rarely observed on the neck or face. Along with these spots there are others which are paler and less distinct and which, from their apparent situation beneath the cuticle, have been designated 'subcuticular'. When abundant, this subcuticular rash imparts to the skin a mottled or marbled aspect, which contrasts with the darker more defined spots before described, although sometimes the two appear to merge into one another. About the end of the first week, the headache ceases, and delirium supervenes. The delirium varies in character. Occasionally it is at first acute followed by great collapse, or the noisy condition passes into low, muttering delirium. More commonly the delirium is never acute even at first. . . . The countenance becomes more dusky . . . while the prostration hourly increases. The tongue becomes dry, brown and rough along the centre and is tremulous; sordes collect upon the teeth and lips. Gradually the eruption assumes a darker shade, and about the eighth or tenth day true petechiæ of a purple or bluish tint appear in the centre of many of these spots. After three or four days, the symptoms of nervous excitement are succeeded by more or less nervous depression and stupor. At first the stupor and delirium alternate, the latter being most marked in the night time. The prostration is extreme; the patient lies on his back, moaning, muttering incoherently, or still and motionless. The expression is stupid and vacant. . . . If spoken to loudly the patient opens his eyes and stares vacantly at those about him, and when told to put out his tongue, he opens his mouth and leaves it open until desired to close it. But all this time the mind is far from inactive; the imagination conjures up the most frightful fancies, to which implicit belief is attached, and of which a distinct recollection may remain after recovery. . . . They who have passed through these mental sufferings can alone imagine their intensity. The teeth and lips are now covered with sordes; the tongue is hard and dry, dark brown or black, contracted into a ball, tremulous, and protruded with difficulty or not at all. . . . The pulse is frequent, small, weak, and undulating and not frequently intermittent or scarcely perceptible. In this state the patient may continue for many hours or several days, with life trembling in the balance, until at last the stupor passes into profound and fatal coma. But on or about the fourteenth day there is often a more or less sudden amendment. The patient falls into a quiet sleep which lasts for several hours, and from which he awakes another man. At first he is bewildered and confused and wonders where he is: but he recognizes his attendants and friends and he is now conscious of his extreme debility. The pulse and temperature have fallen; the tongue is clean and moist at the edges; there is a desire for food. . . . After two or three days the tongue becomes clean and moist all over, the appetite is ravenous, the pulse has fallen to its normal standard or is unusually slow, and the strength is rapidly regained."

It is impossible for me to add to this description, and if I refer briefly to my own clinical experience it is because I saw my cases from a different point of view to Murchison's—that of prevention rather than cure—and consequently noted more particularly the symptoms and signs from a diagnostic point of view. Moreover, in general, while Murchison was dealing practically entirely with uncomplicated cases of typhus, in the vast majority of the cases I saw there was a double or treble infection.

In the strenuous conditions under which extensive typhus epidemics occur the individual who is already weakened from malnutrition and exposure to cold often fails to notice the initial symptoms of the disease, so absorbed is he in the universal struggle for food, clothing, and warmth. Thus, though the ordinary history is that the patient had felt slightly indisposed one or two days previously to the onset of the temperature, the first sign noticed may be sudden mental confusion or a delusion in an apparently healthy individual. For instance, I recollect travelling on a locomotive from Kuibyshev to Moscow with a British colleague, a healthy man of 40. It was winter, and we crouched in front of the engine furnace with the biting wind of the Steppe on our backs. My colleague remarked suddenly that he was an apple, green on one side and red on the other. This was the onset of a severe attack of typhus. Again, it was by no means uncommon for sudden homicidal mania or suicidal attempts to be the first symptom of illness noticed, and I have known tragedies occur through this cause. An interesting fact in connexion with these sudden onsets is the long distance patients delirious with typhus will walk, in spite of the acute toxæmia of the disease, frequently under the impression that they are running away from lice. I have known delirious cases walk as much as 10 miles over the open snow of the Steppe in the depths of a Siberian winter, clad only in a shirt,

before they collapse and are found to be suffering from typhus fever. In the great majority of cases, however, acute delirium is only established at the end of the first week, and a striking feature of the patient's condition then may be his clarity and normal mental state during the day at a time when he is wildly delirious at night. Two very constant symptoms at the onset upon which I would lay stress are headache and bronchitis. The former may be frontal or occipital and its striking intensity may be a useful secondary diagnostic sign.

The clinical diagnosis of typhus fever is frequently exceedingly difficult. The conditions which favour its spread permit the occurrence of other diseases in epidemic form, and except in sporadic outbreaks, in the vast majority of the cases I have seen the diagnosis was complicated by a double infection. Thus, in Rumania, relapsing fever and malignant malaria were widely epidemic at the same time as typhus; in Russia, relapsing fever, malaria, and smallpox; in Poland, relapsing fever and typhoid fever; in China, measles and a malignant form of scarlet fever; in Bolivia, influenza and pneumonia. The clinical picture presented by one, two, or often three of these diseases in one being is obviously extremely complicated, and I have found it, therefore, of fundamental importance to be guided by the two clinical signs of the disease which are, in my experience, the most reliable. These are the absence of the rash from the face, and the fact that the rash does not appear in crops. It is said that very occasionally the typhus exanthem may occur on the face, but for all practical purposes the complete absence from the face is the most important diagnostic sign we know. The absence of "cropping" has been repeatedly stressed by those experienced in typhus since it was first noted by Stewart in 1840.

The date of appearance of the rash and its distribution on the trunk and limbs are, in my opinion, too variable to be of great value in difficult cases. Actually the exact day of the first appearance of the rash is difficult to determine, partly owing to the difficulty of saying exactly when the illness started, and partly because the rash may be extremely faint in its early stages. The commonest time is round about the fifth and sixth days, but this is by no means constant. Peacock, for instance, in a series of 28 cases stated that the exanthem appeared in two cases on the third day, three on the fourth, five on the fifth, seven on the sixth, six on the seventh, two on the eighth, two on the ninth and one on the ninth or tenth. The presence of a rash in some form is however very constant and in Murchison's cases an exanthem was noticed in 93.2% of admissions to the London Fever Hospital. The rash, however, is often faint and transient and may be absent in mild cases in children. With regard to the quantity and appearance of the rash my experience certainly bears out the fact noted by Dr. Browne Langrish as early as 1735. He writes: "Petechial spots and red efflorescence in large areas sometimes appear upon the skin . . . the brighter red they are of, so much the better sign: but when they appear of a purple brown or dusky or black colour they manifest a greater degree of putrefaction." In other words the deeper the colour of the rash, the greater its abundance, and the earlier it appears the more serious is the prognosis.

Apart from the rash, I lay some stress on the character of delirium in cases where this is marked at the onset. The delusions tend particularly to be of a terrifying type, with nightmare dreams, and may be associated with a fear of lice, which the patient imagines are consuming him, covering his pillow, dropping from the ceiling, &c. Occupational delusions are common, and what one may describe as "dissociation" delusions are often characteristic in the later stages of the illness. Thus, the patient asks for his chin to be taken off for shaving, for his legs to be hung up at the foot of the bed or in the wardrobe, or he imagines he has left a leg lying about downstairs. I have been so much struck by this type of delusion in typhus, that I feel it may be of suggestive value in diagnosis of cases in the second week of the disease.

The temperature is so often altered from the classical form by a second disease that, except in sporadic cases in non-endemic areas, it is of little guidance, at any rate in the earlier stages of the disease. On the other hand, errors of diagnosis have occurred through overlooking the fact that a temperature is invariably present in typhus fever, and cases of patients with mental illness and flea-bites have been thought to be typhus.

In sporadic cases, where the disease is commonly uncomplicated, in addition to the three classical symptoms of temperature, nervous manifestations and rash, perhaps the most suggestive symptom, in my experience, is the general appearance of the patient. The dark and heavy flush of the face, the injection of the eyes, often with petechial

hæmorrhages, and the dull stupefied look closely resemble the condition found in individuals in the later stages of an alcoholic debauch. Indeed, cases of alcoholism with vermin bites have been mistaken for typhus when the absence of temperature has been overlooked.

DIFFERENTIAL DIAGNOSIS

Of the differential diagnosis it is difficult to speak briefly, and in practice it is generally impossible definitely to diagnose the sporadic case of typhus before the rash appears on the fourth or fifth day. Until this time there are many febrile conditions which it is impossible to distinguish from typhus fever, as a Weil-Felix reaction is, of course, only present towards the end of the first week. I might, however, mention two common conditions which readily cause error in diagnosis in the earliest stage of the illness, viz. diseases of the enteric group, and the pyo-coccal infections of the central nervous system. A gradual rise of temperature, absence of the typhus facies, and the mental condition of the patient may be of assistance in excluding typhus in cases of the enteric group, but frequently it is impossible to reach a diagnosis until the results of cultures from the fæces and urine and agglutination tests are available. In the case of the pyo-coccal infections early diagnosis on purely clinical ground is often impossible, and reliance has to be placed on the results of the examination of the cerebrospinal fluid and later on the rash and the Weil-Felix reaction. The existence of paralysis or a gradual rise of temperature would be against a diagnosis of typhus. The absence of the rash from the face excludes measles and smallpox, though the prodromal rashes of the latter may closely resemble those of typhus in appearance and distribution. The fact that "cropping" does not occur in the exanthem of typhus helps in excluding the enteric group. Cases which have given rise to mistakes in diagnosis are acute febrile conditions such as pneumonia or influenza, associated with vermin bites on the trunk. In the case of vermin bites, the central puncture can readily be detected with a lens, and the lesion disappears on pressure except for the central dot. Malaria and relapsing fever can, of course, be excluded by blood films taken during the pyrexial stage. Moreover, simple infections with malaria at once react to quinine, and in the case of relapsing fever to the exhibition of salvarsan. On the other hand double infections of these diseases with typhus frequently offer extreme difficulty in diagnosis.

The diagnosis of typhus, at the end of the first week, can be determined by the Weil-Felix reaction. Briefly this depends on the fact that at the end of the first week, or earlier, the blood of cases of louse-borne typhus develops the power of agglutinating the so-called *Proteus X* strains. This reaction is specific for the typhus group of fevers and agglutination of *OX19* appears to be specific for louse-borne and flea-borne typhus. The *OX19* suspension issued by the Oxford Standards Laboratory should be used and the test carried out macroscopically. A strong reaction in a dilution of 1:80 or 1:100 may be regarded as positive when read by the naked eye, but in the later stages of the disease the titre usually rises to 1:1,000 or more. On the other hand, an increase in the agglutinating power of the serum, established by repeated examinations at intervals of two days, is significant, even at a titre of 1:50. From a purely epidemiological point of view the two difficulties about the use of this reaction for diagnosis are first that it occurs only relatively late in the disease—towards the end of the first week—and second, under conditions of work in an epidemic the necessary *OX19* suspensions are not always available.

So far I have dealt only with the clinical aspects of the disease from the point of diagnosis during the febrile period. It is, however, often important from an epidemiological point of view to detect cases which have recently had the disease but have recovered. I should like therefore to refer to certain symptoms in convalescence which occur frequently and may persist for weeks or even months after recovery. At the beginning of convalescence the patient's mental condition is often far from normal. His mental processes are slowed down; he speaks very deliberately and cannot immediately reply to simple questions. This state may continue for some weeks and during this time an attack of mental confusion or even acute delirium may recur. A disconcerting symptom may be the sudden occurrence of transient delusions in a convalescent who is apparently absolutely normal mentally. I was much struck with the frequency in which these occurred in members of our own units. A symptom which persists long during convalescence is a slight tremor of the hands, and localized paralysis, particularly of a limb, occurs during convalescence in a number of cases. Sudden syncope may supervene

at any time in convalescence and in almost all cases great cardiac exhaustion is very manifest for some weeks after the illness. Localized gangrene, including cases of cancrum oris, is, of course, common in cases of typhus, and, though it often develops in the course of the illness, I have seen a number of cases where it only developed some time after the temperature fell. One or more of the above symptoms occurring in a typhus-infected area in an individual apparently weak, either from under-nourishment or as the result of indefinite illness, may suggest that the person has actually had an attack of typhus. When it is possible to carry it out, the Weil-Felix reaction is, of course, of value during convalescence in determining missed cases. The duration of the agglutinating properties of the blood is, however, variable.

With regard to second attacks, though these certainly do occur, they are rare, and, generally speaking, a single attack is considered to confer life-long immunity. Nevertheless, the great difference in the virulence of the strains, with the consequent variation of mortality in successive epidemics in the same country, and the frequency with which patients in an endemic area state that they have previously had the disease, perhaps as a child, suggest that second attacks may possibly be commoner than is generally supposed. I should add, however, that the element of doubt which may arise in diagnosis, together with the fact that there is generally only the patient's statement as to the previous diagnosis, makes any accurate conclusions impossible under epidemic conditions.

ADMINISTRATIVE MEASURES OF CONTROL OF WIDESPREAD EPIDEMICS

Though the measures taken are not likely to be applicable to Great Britain it may be of interest to outline the broader administrative steps we took when dealing with widespread epidemics of typhus fever.

The personnel of a number of units was established, including doctors, nurses, and subordinate medical auxiliaries. All were young and all were protected by the use of special clothing. Arrangements were made for the regular disinfestation of the garments and for bathing the personnel. The stores required included portable baths and showers, fuel for heating water, soap, hair clippers and scissors, nail brushes, towels, &c., in addition to as good rations as it was possible to obtain. Units were sent into the various regions and were administered centrally in Poland from Warsaw, in Russia from Moscow and Kuibyshev, and, two years ago, in China from Chungking and Sian.

The next step was to put a cordon round healthy areas, with the aid of the military and barbed wire, to prevent the ingress of infected refugees. This was in many cases done locally, though eventually a cordon had to be established right across Europe, from North Poland to Rumania. Refugees were only allowed to enter this "clean" zone at certain points established on the roads and railways. Patrols watched the open country and brought stragglers into the disinfesting points. At each such point were arrangements for bathing and disinfestation, and all persons passing the cordon were thoroughly "de-loused" with their belongings. The size of the work may be gathered from the fact that at one centre alone—Baranowice, on the Polish-Russian frontier in 1921—we were for a long time disinfesting each day 10,000 refugees returning to Poland from Russia. The method of disinfestation varied according to the country and the apparatus available. In Poland, steam and cyanide were both used, the latter being employed on an extensive scale on the frontiers. At Baranowice, where the refugees arrived chiefly by train, a tunnel was built, into which hydrocyanic gas could be introduced. On the arrival of each train, all the passengers were given a blanket and told to strip, leaving their garments and all their belongings on the train. Each person was then bathed in hot water with soft soap and paraffin, while the train was backed into the tunnel, the engine uncoupled, and cyanide gas liberated in the tunnel. When the bathing of the refugees was completed, the train was pulled out of the tunnel by means of a rope attached to a locomotive and was allowed to air. In due course the passengers dressed, gave up their blankets, and continued on their journey. In Mesopotamia, we used a locomotive with waggons attached, into which steam, first saturated and superheated, could be passed. The train included accommodation for personnel and thus constituted a unit which could be moved to any point where typhus broke out.

In Russia, we utilized the Russian baths, with which every village is equipped. These are log huts in which fires are made under heaps of stones, which are thus heated to a high temperature. Buckets of water are thrown on the stones, the water immediately evaporating into clouds of steam. The population was first bathed and de-loused in

the bath, and then the amount of heat and steam were increased so as to deal with the bedding and clothing. Subsequently, no further water was thrown on the stones, and the heat of the hut was allowed to dry out the material.

For furs, which are very readily infested with lice and which do not lend themselves to the ordinary methods of disinfestation, crude naphthalene was used. A large box or chest was constructed at the entrance to the house and half-filled with crude naphthalene. Into this all furs and outer garments were dropped on entry to the house and left there until the following morning. I should mention that in winter in a cold country it is, of course, sufficient to hang one's garments in the open for the night for every louse to be destroyed. Whether the nits survive or not depends on the degree of cold, but there is in any case no evidence that these can transmit the disease.

In China, where padded garments have to a great extent superseded furs, brick ovens were used. These could be built rapidly in large numbers of local unburnt brick, and were heated with wood fuel or oil. The material for disinfestation was introduced and left for half an hour, care being taken to hang the bedding and clothing so that complete circulation of the hot air was provided for. Ironing was found very useful on a wide scale in Russia, households being supplied with a flat iron and instructions how to use it for the destruction of lice. Other improvised methods of dealing with lice were also employed; e.g. the Serbian barrel, sack disinfectors, &c., but these have two great drawbacks; firstly it is difficult to employ them on a really big scale, and secondly the fact that the garments emerge wet is a very great disadvantage, especially in a country where all moisture at once freezes hard. A further immediate measure was the acquisition and equipping of houses as hospitals for the sick, including the provision of medical stores, food, &c., and ambulance facilities.

On arrival in an area, we at once took steps to improve the nutritional conditions existing amongst the population. With typhus, especially if combined with malaria, a vicious circle is established. In the spring, the existence of these two diseases interferes with the proper sowing of the crops, with the result that the harvest is correspondingly decreased and malnutrition is increased, resulting in more typhus in the following winter and spring. This results in still less sowing during the spring and consequently more malnutrition in the following winter. To break this circle the first step was to import and issue food, and at one time over 5,000,000 were being fed daily. Concurrently, we imported large numbers of tractors, which, in lines of 30 each ploughing furrows 3 miles long, worked throughout the twenty-four hours, running at night by the aid of headlights. Seedcorn from abroad and thousands of horses from Central Asia were imported at the same time, and within two years the nutritional condition of the population was completely altered and typhus rapidly fell to its endemic normal. This was a good example of the rapidity with which epidemic typhus in an endemic area reacts to improved conditions of life.

CONTROL OF TYPHUS IN GREAT BRITAIN

The lessons to be learnt from these notes regarding control of typhus in Great Britain may be conveniently summarized as follows:

(1) All experience tragically demonstrates the great danger to which personnel working amongst typhus patients are exposed, and consequently the need for the most careful personal supervision of their activities by the medical officer in charge. The most dangerous part of the work is the search for cases, the work in the admission block of a typhus hospital, the removal and disinfestation of the bedding, and also, unless careful precautions are taken, the collection of blood for the Weil-Felix reaction. In view of the lower mortality at earlier ages, only young personnel should be utilized. In the various anti-typhus units with which I have worked I would never include anyone over 40, and, where possible, only personnel under 30 were employed. No vaccine has yet been shown to protect workers under field conditions, so that in the meantime reliance should not be placed on immunization, as this may lead to relaxation of established methods of protection. The hair of all personnel working with typhus cases should be cut short and if possible shaved, including hair on the body. Protective clothing must invariably be worn, and a suitable garment for this purpose is described in the recent memorandum of the Ministry of Health on louse-borne typhus fever (Memo 252/MED). I would emphasize that protective clothing should not be worn for more than two or three hours without changing. In practice it is remarkable how rapidly a louse deposited

on the uncongenial surface of cloth crawls about until it finds an aperture at the face or wrists, through which it can gain access to the warmth and sustenance provided by the naked flesh.

Opinion is divided as to the necessity for using masks, but they should certainly be worn in any work in which the disturbance of dust may be involved, in view of the known high infectivity of the dried fæces of lice. If masks are worn, they should either cover the eyes, or be supplemented by goggles, as infection can occur through dried faecal material falling on the conjunctiva. Gloves, coming well up the forearm, must, of course, be worn. Rubber gloves are the best, as they not only fit more closely on the forearm but they also allow of the finer manipulation required in the examination of the patient and the shaving, &c. during his disinfestation. While rubber gloves are the most suitable from many points of view, the ease with which they are torn constitutes in the field a grave drawback. For ambulance drivers, sanitary inspectors, disinfestors, &c., closely woven cloth gloves with a snugly fitting gauntlet are suitable. With cloth gloves, however, it is in practice difficult to avoid the formation of folds between the gauntlet and the sleeve of the garment, down which lice can crawl if the outfit is worn for any considerable length of time. Gumboots or goloshes are the most useful footwear. It is worth mentioning for the benefit of any who may be called upon to actually work and live in a heavily infected typhus area after the war, that when it is necessary to sleep in squalid peasants' houses, infested railway trains, &c., a special type of sleeping bag will be found to greatly lessen chance of infection. Such a bag, which I designed for use in Poland and Russia, was made of closely woven cotton material, about 10-12 ft. long, drawn up at the end with a circular tape which could be fastened up from the inside. Over the face were two thicknesses of gauze supported by a light metal frame. The whole bag could be boiled, and forming, as it did, complete protection from the inroads of all insects—bugs, fleas and lice—enabled one to enjoy a quiet night in comparative security.

Secondly, I would stress the rapidity with which the disease spreads, and the difficulty of tracing "contacts" in practice. In connexion with the word "contacts" there is no analogy among the diseases occurring in Great Britain to the period of infectivity of an individual who subsequently develops typhus fever. A "contact" is generally taken to cover any person exposed to infection from a patient during the time he is ill. In the case of typhus, however, the individual harbouring infected lice is capable of spreading infection from the day on which he acquires the disease to the time when he is diagnosed and disinfested, i.e. during the whole of the incubation period. The number of infected lice on an individual is, of course, far greater during the time he is actually suffering from the disease, but the incubation period cannot be overlooked from an epidemiological point of view. In this paper, therefore, the word "contacts" is used in a much wider sense than ordinarily. The incubation period may be taken as twelve to fourteen days, and after this there is a period of four to five days before the rash develops so that, even if the disease is diagnosed at the earliest possible moment (which is exceptional in sporadic cases), there is a period of sixteen to seventeen days during which the patient has been making "contacts". If, as is common in sporadic outbreaks, the disease is first recognized when the secondary cases occur, it can well be pictured how impossible it is to identify all the "contacts". We are, therefore, often driven to the possibility of dealing only with the very immediate "contacts"—the family, fellow workers, &c., whereas the most remote "contacts" are much the more numerous and are largely unknown. It is for this reason that I am strongly of opinion that the reduction of lice amongst the population generally is as important as the tracing and disinfestation of more remote "contacts".

A further point that should be mentioned is that the mechanical transference of the louse is, I believe, much the commonest method of infection. A louse probably rarely voluntarily leaves an individual in cold weather except when he has a high temperature or is dead. Mechanically, however, lice are transferred in a number of ways. They may, of course, be shaken from the individual on to his pillow and sheets or, when he is undressing, on to the carpet and chairs of the bedroom. They can also be shed as their host walks or sits down, so that shop floors, railway compartments, &c., and particularly the walls and flooring of public markets become sources of infection. Perhaps one of the commonest methods of transference is rubbing shoulders in a crowd. This was certainly the case in Poland and Russia, where men visiting the market to purchase

food for our Units almost invariably returned with one or more lice upon them. In a typhus area, it is remarkable how chary people are of entering a crowd and how everyone in walking takes the greatest care not to touch any passer-by. This is a very important precaution, as a number of our personnel, not connected with typhus work, almost certainly acquired their attack of the disease from individual lice brushed off from passers-by in walking along a crowded street. Single lice can, of course, transmit the disease and an interesting fact is that many individuals in our Units, including myself, who developed typhus or relapsing fever never knew that they had had a louse upon them. It is doubtful whether infection occurs by regurgitation as in the case of the plague flea, and the ordinary method of infection is by self-inoculation—the individual scratching the bite and so crushing the louse and rubbing in the contents of its intestinal canal.

I have emphasized earlier how directly epidemics of typhus, even in endemic areas, are associated with malnutrition, and a point of great practical importance is the rapidity with which a widespread outbreak wanes in the face of improved nutritional and economic standards in the population generally. Once the disease is established in a community, even on a small scale, steps should at once be taken to combat this important epidemiological factor.

It is clear that, as the disease can readily be carried by a single louse, disinfestation of the patient, the "contacts", the premises, the ambulance, and the personnel employed must be absolutely complete, and must therefore be done under the direct supervision of a medical officer. Not only must this officer assure himself beforehand that the disinfecting machine to be used is effective, but during disinfestation he must make certain that the apparatus is being correctly used. We all know the temptation, for instance, there is to use little or no saturated steam and an abundance of superheated steam, or to bundle blankets together for hot-air disinfestation in order to save time.

It is essential to reserve an ambulance for typhus cases and the vehicle which is chosen should be one which lends itself to complete cleansing of the interior and which affords no harbourage to insects. The patient, prior to removal, should be completely enveloped in an extra long sheet and lifted on to the stretcher so that any lice shaken off in the process are caught in the wrapping.

I need not enter into all the details of the disinfestation of cases on arrival at hospital prior to admission to a ward, as these will suggest themselves in the light of my remarks with reference to the danger of the transference of the disease to personnel. There are, however, three important points: First, every hospital intended for typhus cases should be provided beforehand with a properly equipped admission block and a disinfecting apparatus and should be staffed by young personnel trained in thorough disinfestation. Second, in addition to the destruction of the lice, the greatest care should be taken to ensure that all nits are also dealt with. The blood of a typhus patient is highly infectious for the two weeks of illness, and a nit which has been overlooked may hatch out, feed on the patient, and eventually cause the disease in the nurse. For this reason it has been recommended that all patients should undergo a second disinfestation a week after they have been admitted to hospital. Third, it is useless to place any reliance on disinfectants in the bath given to the patient, as it is impossible to utilize a sufficiently strong solution of an ordinary disinfectant to ensure the death of the insect in the relatively short time in which it is exposed. The removal of the lice by bathing in mechanical and ordinary soap, possibly soft soap mixed with paraffin, is sufficient if conscientiously applied with a nail brush after the patient has been shaved.

The identification of the "contacts" of a case of typhus offers very considerable difficulty and indeed, as mentioned above, it is difficult to define what actually constitutes a "contact" from the point of view of disinfestation. In the case of immediate "contacts"—members of the same family, co-workers, &c.—the most thorough disinfestation must of course be carried out. With regard to more remote "contacts" the decision must, in my opinion, be made in the light of individual circumstances. Any individual who carries lice in an area where typhus exists is a danger to himself and to other people, and as such must be disinfested. The position is much more difficult in the case of persons normally clean who may, possibly only for a few moments, have been in contact with an individual who subsequently developed typhus. Probably the best method of dealing with these cases is to explain the danger to the individual concerned and advise him to undergo disinfesta-

tion. It is clear that it is impossible either to trace or disinfest any but a small proportion of the more remote "contacts" of a man who for twelve days and possibly sixteen has been living an ordinary life, travelling by bus or train, at the cinema, in shops, &c., and who has subsequently developed typhus. It is for this reason that it is essential to insist on the general disinfestation of the population in addition to measures against all known "contacts". "Contacts" should be kept under surveillance for three weeks.

With regard to the disinfestation of the premises, cyanide gas is the most satisfactory. Indeed we have no evidence that sulphur or formalin as applied in ordinary disinfection has any certain lethal effect on lice or *Rickettsia* bodies. The fact that armchairs, sofas, wardrobes, &c., are all likely to be infective in the bedroom of a typhus case, and that none of these can readily be disinfested in an ordinary disinfector, apart from the danger of handling and transporting them, makes disinfestation in situ essential. Bedding and clothing of the patient and the immediate "contacts" should be particularly thoroughly disinfested. It is important to remember that lice may drop from such material and the disinfesting station should, therefore, be reserved entirely for typhus bedding and clothing until this has been dealt with. Subsequently, and before any other material is introduced for disinfection, the station must be thoroughly cleansed. One point that may be overlooked is the fact that clothing may have been sent to a laundry from a case who later developed typhus. The method to be employed for disinfestation will generally be determined by the disinfesting apparatus available. Saturated steam is, of course, thoroughly effective as is hot air, provided the garments, &c., are so suspended as to allow of free circulation of air about them. *Rickettsia* and lice are both killed by exposure to dry heat for five minutes at a temperature of 140° F., and instantly by exposure to a temperature of 212° F. when moist heat is utilized. Finally, in this connexion, when disinfestation is completed the cleansing of the ambulance, bedding van, disinfesting station, and the personnel engaged must not be overlooked.

Immediately typhus occurs, all practitioners should be kept informed of the existence and extent of the disease in their locality, and if necessary a brief description of some of the important diagnostic signs should be circulated. The ease with which cases of typhus are missed is well shown in figures given by Davidson and Cruickshank. In the period 1901 to 1926, 87 groups of cases occurred in Glasgow, and in 36 of these the diagnosis of the primary case was missed. The analysis of the diagnosis of the first case in each group was: Typhus 51; enteric fever 22; pneumonia 5; other diseases 9.

As typhus may masquerade under such varying clinical forms, all death certificates should be scrutinized by the Medical Officer of Health for suspicious deaths and he should keep in constant touch with all doctors in his area engaged in general practice. In addition a close search for cases must be maintained by the Medical Officer of Health and his staff, particular regard being paid to cases of illness where a doctor is not in attendance. In view of the mildness of the disease amongst children, absentees from school must be closely investigated. Propaganda informing the public how the disease is carried, how lice can be killed and outlining the disinfesting facilities available is of the greatest importance.

CONCLUSION

Though under-nourishment and fatigue render individuals more liable to typhus, the disease will readily attack individuals in perfect health and living under good conditions, and if typhus is imported into this country at the present time, the first case may well not be associated with conditions of poverty, dirt or malnutrition. The present constant air-traffic between the Continent and this country is limited to a type of individual who is unlikely to harbour lice, but who may easily be infected abroad and develop the disease after arrival. Refugees and prisoners of war arriving in this country, are, of course, in another category. The great variation in the virulence of the strains constitutes a further complication, and it must not be forgotten that an initial case in Great Britain occurring in a well-nourished subject may be either of the grave, classical type, or very mild, and thus readily overlooked. I would emphasize the rapidity of the spread of the disease in a louse-infested population, the difficulty of the diagnosis, the necessity for complete thoroughness in disinfestation and the importance of detailed supervision of the protection of personnel, in view of the great danger to which they are exposed.